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TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371		Attorney's Docket Number 08059.0002 U.S. Application No. 09/622535
International Application. No. PCT/NZ98/00098	International Filing Date July 10, 1998	Priority Date Claimed February 20, 1998 February 24, 1998

Title of Invention: A MULTI-LAYER DISPLAY AND A METHOD FOR DISPLAYING IMAGES ON SUCH A DISPLAY

Applicants For DO/EO/US: 1) Pita WITEHIRA and 2) Gabriel Damon ENGEL

CUSTOMER NUMBER 22852

Applicants herewith submit to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

3. [X] This is a FIRST submission of items concerning a filing under 35 U.S.C. 371.
4. [ ] This is a SECOND or SUBSEQUENT submission of items concerning a filing under 35 U.S.C. 371.
5. [ ] This express request to begin national examination procedures (35 U.S.C. 371(f)) at any time rather than delay examination until the expiration of the applicable time limit set in 35 U.S.C. 371(b) and PCT Articles 22 and 39(1).
6. [X] A proper Demand for International Preliminary Examination was made by the 19th month from the earliest claimed priority date.
7. [X] A copy of the International Application as filed (35 U.S.C. 371(c)(2))
   a. [X] is transmitted herewith (required only if not transmitted by the International Bureau).
   b. [ ] has been transmitted by the International Bureau.
   c. [ ] is not required, as the application was filed in the United States Receiving Office (RO/US).
8. [X] A translation of the International Application into English (35 U.S.C. 371(c)(2)).
9. [X] Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371(c)(3)).
   a. [ ] are transmitted herewith (required only if not transmitted by the International Bureau).
   b. [ ] have been transmitted by the International Bureau.
   c. [ ] have not been made; however, the time limit for making such amendments has NOT expired.
   d. [X] have not been made and will not be made.
10. [ ] A translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).
11. [ ] An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4)).
12. [X] Annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)).

Items 11. to 16. below concern other document(s) or information included:

13. [ ] An Information Disclosure Statement under 37 CFR 1.97 and 1.98.
14. [ ] An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.
15. [ ] A FIRST preliminary amendment.
    [ ] A SECOND or SUBSEQUENT preliminary amendment.
16. [ ] A substitute specification.
17. [ ] A change of power of attorney and/or address letter.
18. [ ] Other items or information:
    a. [ ] Verified Small Entity Statement.
    b. [ ] Copy of Notification of Missing Requirements.

.S. APPLICATION NO 09/622535	INTERNATIONAL APPLICATION NO.	ATTORNEY DOCKET NUMBER
	PCT/NZ98/00098	08059.0002

7. [X] The following fees are submitted:	CALCULATIONS
Basic National Fee (37 CFR 1.492(a)(1)-(5)):	
Search Report has been prepared by the EPO or JPO.....$840.00	$840.00
International preliminary examination fee paid to USPTO (37 CFR 1.482).....$670.00	
No international preliminary examination fee paid to USPTO (37 CFR 1.482) but international search fee paid to USPTO (37 CFR 1.445(a)(2)).....$690.00	
Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO.....$970.00	
International preliminary examination fee paid to USPTO (37 CFR 1.482) and all claims satisfied provisions of PCT Article 33(1)-(4).....$ 96.00	
ENTER APPROPRIATE BASIC FEE AMOUNT =	**$840.00**
Surcharge of $130.00 for furnishing the oath or declaration later than [ ] 20 [ ] 30 months from the earliest claimed priority date (37 CFR 1.492(e)).	$

Claims	Number Filed	Number Extra	Rate	
Total Claims	17-20=	0	X $18.00	$
Independent Claims	4- 3=	1	X $78.00	$ 78.00
Multiple dependent claim(s) (if applicable)			+$260.00	$260.00
TOTAL OF ABOVE CALCULATIONS =				**$1178.00**
Reduction by 1/2 for filing by small entity, if applicable. Verified Small Entity statement must also be filed. (Note 37 CFR 1.9, 1.27, 1.28)				$
SUBTOTAL =				**$1178.00**
Processing fee of $130.00 for furnishing the English translation later than [ ] 20 [ ] 30 months from the earliest claimed priority date (37 CFR 1.492(f)). +				$
TOTAL NATIONAL FEE =				**$1178.00**
Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31). $40.00 per property +				$
TOTAL FEES ENCLOSED =				**$1178.00**
Amount to be refunded				$
charged				$

a. [X] A check in the amount of **$1178.00** to cover the above fees is enclosed.

b. [ ] Please charge my Deposit Account No. _____ in the amount of$_____ to cover the above fees. A duplicate copy of this sheet is enclosed.

c. [X] The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. 06-0916. A duplicate copy of this sheet is enclosed.

The Commissioner is hereby authorized to charge any other fees due under 37 C.F.R. §1.16 or §1.17 during the pendency of this application to our Deposit Account No. 06-0916.

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Submitted: August 18, 2000

A MULTI-LAYER DISPLAY AND A METHOD FOR DISPLAYING IMAGES ON SUCH A DISPLAY

TECHNICAL FIELD

This invention relates generally to display devices and more particularly, to a display structure comprising multi-layered images and a method of extracting depth from two dimensional video data to display on such a device.

BACKGROUND ART

Conventional display devices present images on a two dimensional screen. Common displays are cathode ray tubes (CRTs), liquid crystal displays (LCDs), Field Effect Displays (FEDs), and projection displays, among others. Various attempts have been made to incorporate the illusion of depth on two dimensional displays. These methods achieve the illusion of depth by presenting separate images to each eye of the viewer.

The main methods of achieving the illusion of depth have been stereoscopic and auto-stereoscopic displays.

Stereoscopic displays generally use composite images which are split into two images by glasses worn by the viewer. Each eye piece in the glasses will allow certain characteristic light patterns through to each individual eye. Popular methods of achieving this are through the use of polarisation, shutter glasses, defraction grating, multi colour lens, and dual screen head mounted displays.

Auto-stereoscopic displays do not use glasses but instead generally use a lens configuration in which stereo images on a screen are aligned through lens or optical grating to focus in the general area of the viewers' individual eyes.

One main problem associated with these displays reside in the inability to gain convergence of stereo images to match the distance between the viewers' eyes. Incorrect convergence leads to disorientation and possible nausea when viewed for extended periods. In the case of most auto-stereoscopic displays the viewing area is limited to the focal length of the lens used. This limits the number of simultaneous viewers of a single screen. Traditional auto stereoscopic displays are limited to one or two simultaneous viewers. While, traditional stereoscopic displays require all users to wear glasses. In addition each of these methods require head tracking devices to be incorporated in order to achieve motion parallax.

Certain designs have been made that use multiple levels of images.(US Patent 4,736,214) These designs incorporate reflected images from single or multiple sources. The reflected images of these designs produce "ghostly" multi layered images, which are generally unacceptable for normal lighting conditions.

Images transmitted to these display devices via antenna, VCR, cable etc. are generally compressed during transmission. It is common for these compression algorithms to compress based on pixel change between consecutive frames.

It is an object of the present invention to address the foregoing problems or at least to provide the public with a useful choice.

Further aspects and advantages of the present invention will become apparent from the ensuing description which is given by way of example only.

DISCLOSURE OF INVENTION

It is the purpose of this invention to specify a display which improves upon the limitations of display devices mentioned above, while incorporating actual depth.

According to the present invention depth is created by combining multiple layers of selectively transparent screens. Each screen is capable of showing an image. Each foreground screen is also capable of becoming transparent.

The preferred embodiment of this invention creates an improved display device incorporating depth, by combining multi-layers of selectively transparent screens to create true depth while incorporating common compression algorithms to extract images into separate channels to be displayed on each screen of the multi-layered display. Implementation of multiple techniques have been used to achieve this end, which solve many problems exhibited in the prior art.

Reference throughout this specification will now be made to the present invention as utilising LCDs for each screen layer. However, it should be appreciated by those skilled in the art that other types of screens that can selectively show an image and selectively become transparent may be used in conjunction with the invention, not necessarily being LCDs.

In a preferred embodiment of the present invention the screens are aligned parallel to each other with a pre-set distance between them. This distance depends on the level of desired depth related to the screen sizes. Typically this distance is ¼ the vertical height of the front screen although the actual distance may be changed to fit the desired effect. The distance between screens may also be varied in real time to enhance the effect.

Images displayed on the screen furthest from the viewer (background screen) will appear at some depth behind images displayed on the screen closest to the viewer (foreground screen). The transparent portions of the foreground screen will allow viewers to see images displayed on the background screen.

This arrangement of layering multiple screens allows images to be presented at multiple levels giving the viewer true depth without use of glasses or lens. It also allows for motion parallax without head tracking devices.

Additional layers may be added to give greater depth to the display.

In addition a refractor may be placed between the screens to increase viewing angle. This refraction layer bends light such that viewing angle is increased to the full size of a screen placed in front of the refractor. The refractor may be a parallel sheet of optically clear material or any other type of lens including frensel lens.

If the foreground screen device chosen requires a polarised light source to display an image then that polarised light source may emanate from a background screen. This is accomplished by placing a polarisation sheet in front of a non-polarised screen or using a polarised light output display such as an LCD as the background screen.

Polarised light emanating from a background screen allows a foreground screen of LCD structure to remove its rear polariser while still displaying an image. This is due to the fact that the background screen provides the polarised light necessary to produce a viewable image on the foreground screen.

Removing the number of polarisers in an LCD configuration has the advantage of reducing the number of components and increasing the brightness of the display.

In such a configuration the foreground image will no longer appear on the foreground screen if the polarised source is blocked. By placing a highly diffuse material between the polarised light source and the foreground screen the foreground images will disappear where the polarised light is blocked. This gives the illusion that the foreground image displayed is passing behind the diffusion source. To enhance the effect the diffuser may also contain an image.

For example, the foreground screen displays an arrow moving from the left to the right of the screen. Inbetween the foreground screen and the polariser is placed an image of an apple printed on a diffuse material. When the arrow is in a position to have its polarised light source blocked by the diffusion material it will appear to fall behind the apple imprinted on such diffusion device.

By using a selective diffuser in place of the diffusion material one may selectively diffuse images presented on the rear screen allowing for infinite depth to be conveyed.

When multiple layered LCDs are used the polarisers of said LCDs must align in such a way that the polarisation angle of the background LCD aligns with the polarisation angle of the rear of a foreground LCD. Aligning polarisers is not necessary in cases where high brightness is desired or if the foreground image can be inverted. In this case an inverted foreground image will appear non inverted (inverse of an inverted image = non inverted image).

It may be necessary in certain screen combinations to include a slightly diffuse layer to eliminate moiré interference patterns. This has the additional effect of eliminating the need to align polarisers and increasing angle of view.

Each layer of the display will have an individual video signal. These signals may originate from separate sources or be extracted from a single source conventional signal.

In a two layer display using separate sources the background may be transmitted as a signal and the foreground transmitted as a second signal to their respective screen. For example, the background image may be of a mountain and the foreground image of a car passing in front of the mountain.

Separate sources may be filmed with multiple conventional cameras, or three dimensional cameras, or blue screen, or chroma key or alpha channel or any combination of industry standard cameras.

Single source depth extraction may be performed using conventional compression algorithms used in transmission of video data. Prior Art video compression algorithms commonly utilise pixel change between consecutive frames in order to reduce the bandwidth of the data transmitted. This data on pixel change taken from the video compression algorithm can be used to extract depth based on the amount of change each pixel undergoes.

Compressed signal is sent to display where video streams to each layer are extracted from the signal based on pixel change.

For example, a standard video may be made of a car passing a mountain. The camera is fixed such that the car passes the field of view while the mountain remains still in the frame.

In such a video the pixels representing the passing of the car will change whereas the pixels representing the mountain will remain constant. Thus, the pixels with the most change (car) will be assigned to the foreground screen where the pixels with the least change (mountain) will be assigned to the background screen.

It should be understood that portions of this summary devoted to polarisation are not limited to LCD structures as it can be easily understood by those skilled in the art that other non polarised displays may be adapted to incorporate certain polarisation characteristics if so desired.

Further more, it is easily understood by those skilled in the art that the above summary covers the use of all screen types not only LCDs. The only requirement for the screen type is an ability to be transparent. As such it should be understood to cover, but is not limited to Projection, CRT, FED and LCD screens.

BRIEF DESCRIPTION OF DRAWINGS

Further aspects of the present invention will become apparent from the following description which is given by way of example only and with reference to the accompanying drawings in which:

Figure 1 is a diagrammatic view of a basic multi-layered display in accordance with one embodiment of the present invention.

Figure 2 illustrates a multi-layered screen with a refractor in accordance with one embodiment of the present invention.

Figure 3 illustrates the moiré interference pattern in multi-layered displays in accordance with one embodiment of the present invention.

Figure 4 illustrates a diffuser and its effect on the moiré interference pattern in accordance with one embodiment of the present invention.

Figure 5 illustrates a multi-layer display with added depth in accordance with one embodiment of the present invention.

Figure 6 illustrates a multi-layered display with added clarity in accordance with one embodiment of the present invention.

Figure 7 illustrates a tri-level display in accordance with one embodiment of the present invention.

Figure 8 illustrates a method of displaying images to each screen level in accordance with one embodiment of the present invention.

BEST MODES FOR CARRYING OUT THE INVENTION

In the following, detailed descriptions of the preferred embodiments of this invention are revealed. Although a complete specification is revealed it should be understood by those skilled in the art that each aspect of the preferred embodiments may be used independently or in conjunction with other illustrations of this invention while still conforming to the general specification of a multi-layered display device.

The preferred embodiments of this invention create an improved display device incorporating depth, by combining multi-layers of selectively transparent screens.

A simplified multiple layered image display is shown in Figure 1. A background screen 1 is placed at some distance 2 behind a foreground screen 3. In some display types such as LCDs back lighting 4 may be required. Each screen is capable of showing images 5, 6. Images displayed on the foreground screen 6 appear to be closer than images shown on the background screen 5.

The addition of a refractor placed between screens is represented in Figure 2. Light 7 transmitted to the viewer 8 is bent to 9 at refraction angle 10 of the material such that the edge of the rear screen is not seen from any angle of view. Without the refraction of light the edge of the rear screen would be clearly seen 11 from any angle less than 90 degrees.

For minimum distortion a sheet of parallel optically clear material such as glass or acrylic may by used as a refractor 12. Such a refractor would restrict the front screen 3 to being of a smaller size than the background screen 1. In a preferred embodiment of the present invention the foreground screen size would have its edge no less than 135 degrees from the edge of the rear screen.

In another preferred embodiment the refractor may be a lens including but not limited to frensel. In this embodiment the screens may be of similar size.

The addition of a slightly diffuse layer 13 placed between screens is shown in Figure 4. Without this layer, interference 14 is created by the combination of slightly different pixel patterns of subsequent screen layers. Placing the diffusion layer 13 between screens slightly diffuses the pixel pattern in each screen eliminating interference 15.

Alternately interference can be eliminated by using a stripe pixel pattern on one screen and a 45 degree diagonal pixel pattern on another.

For further clarification a complete assemble is shown in Figure 5. This combination produces a display with a finite true depth defined by the distance between screens 3, 6. It also creates an infinite depth illusion with the addition of a selective diffuser.

A polariser sheet 17 is placed at the front of the rear screen 1. This creates a polarised light source. Alternately the rear screen could also be an LCD with a polarised output. In front of the polariser is placed a selective diffuser 18. In front of the diffuser is a refractor 8. In front of the refractor is placed a LCD without a rear polariser 16.

When the selective diffuser is set to transparent, the rear screen outputs polarised light to allow an image on the foreground screen to be visible.

When the selective diffuser is set to diffuse, the rear screen polarised light output is converted to diffuse light, which renders the foreground image invisible.

With certain screen technologies such as LCD it is desirable to have the ability to render the foreground screen opaque. This preferred embodiment is represented in Figure 6. This combination produces a display in which the foreground screen is rendered opaque. In this configuration the rear screen 1 is followed by a refractor 12 which is followed by a selective diffuser 18 which in turn is followed by the foreground screen 3. To make images on the foreground screen opaque the selective diffuser is selected to diffuse the area behind the area selected to be opaque.

In yet another embodiment of the present invention Figure 6 represents a Tri-layer display incorporating most of the previously mentioned techniques. This display provides three finite depth planes with the foremost screen 19 being selectively opaque due to the selective diffuser 18 placed behind it. The middle LCD screen 16 would have infinite depth due to its lack of rear polariser and the ability of the selective diffuser 18 in front of the rear polariser 17 to diffuse polarised light required for its operation.

The general method of transmitting images to the screens is represented in Figure 8. Image 19 is transmitted to the background screen 1. Image 20 is transmitted to the foreground screen 3.

Alternatively the separate video signal can be extracted from a single image using data produced by most common video compression algorithms. For example a video signal is transmitted of a car passing in front of a mountain 21, creates a sequence of frames 22. This sequence is fed through a video compression algorithm 23 which converts the image to a sequence of numbers representing pixel properties such as pixel colour, pixel location and amount of pixel motion between consecutive frames.

In this example, pixels with a change value above a threshold of X via path 24 to the foreground screen while pixels with a change value below X are sent via path 25 to the background screen. In the present implementation (Figure 8) pixels representing the car have a high value for pixel change and will be directed to the foreground screen and the mountain having a pixel change value of less than X will be directed to the background screen.

It can be easily understood by those skilled in the art that the threshold value and tolerance of this value may be adjusted to gain a variety of outputs. In addition multiple threshold values may be defined in multi-layered displays with over two layers.

Thus, it can be seen from the foregoing detailed description and attached drawings that the present invention includes methods of displaying depth in a display allowing for motion parallax, true convergence, and wide angle of view without the viewing restrictions of prior art displays.

It can also be appreciated that taken individually each component enhances the depth of the display but may also operate independently and in combination to enhance traditional displays. It is obvious to someone skilled in the art that the following claims may be combined in various manners.

Aspects of the present invention have been described by way of example only and it should be appreciated that modifications and additions may be made thereto without departing from the scope thereof.

CLAIMS

1. A display using multi-layered images each layer formed by a display device or combination of display devices in which the foreground screen(s) is(are) selectively transparent and with a slightly diffuse layer placed on the front of a background image.
2. A display as claimed in Claim 1 which has a refractor between layers.
3. The display as in Claim 2 with said refractor being of optically clear material placed between images such that the image in the foreground is no less that 45 degrees from the edge of the screen to its rear.
4. The display as in Claim 2 with said refractor being a fresnel lens.
5. The display as in either Claim 2 or Claim 3 with said refractor diffused on the side facing the rear screen.
6. A display as claimed in Claim 1 wherein the space between images is able to be adjusted in real time.
7. A display using multi-layered images each layer formed by a display device or combination of display devices in which the foreground screen(s) is(are) selectively transparent with layered images being aligned such that a 45 degree angle can be measured in relation to their respective pixel alignment configurations.
8. A display using multi-layered images each layer formed by a combination of transmissive polarized display devices in which the foreground screen(s) is (are) selectively transparent and one or more internally facing polariser is removed.
9. A display as claimed in Claim 8 wherein one or more object is introduced to block polarised light to a foreground image.

10. The display as in any one of Claims 1 to 9 with a selective diffuser used to diffuse light which renders a foreground image opaque.

11. The display as in any one of Claims 8 to 10 with selective diffusion layer which renders a foreground image requiring polarised light transparent by blocking polarised light.

12. A display as claimed in any one of Claims 1 to 11 incorporates digital or analog depth extracting techniques from 2d images.

13. A display as claimed in any one of Claims 1 to 12 which incorporates digital or analog depth extracting techniques from 2d images were amount of change to pixel from previous and next frame indicate amount of depth to assign.

14. A display as claimed in either Claim 12 or Claim 13 where the amount of focus in a subset of pixels indicates the amount of depth to assign.

15. The display as claimed in any one of Claims 12 to 14 where the amount of sharpness in a subset of pixels indicates the amount of depth to assign.

16. A display substantially as herein described with reference to and as illustrated by the accompanying drawings.

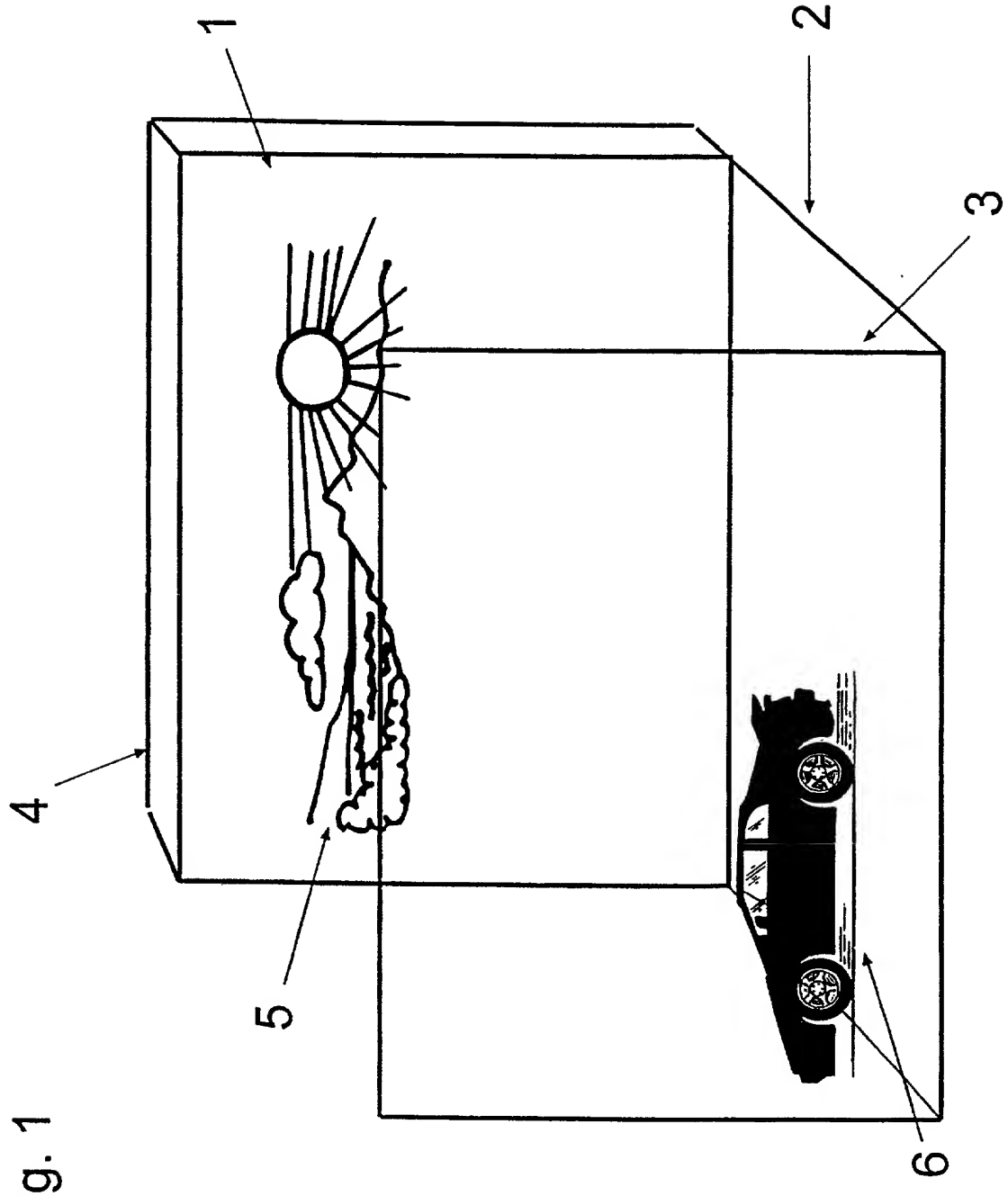

Fig. 1

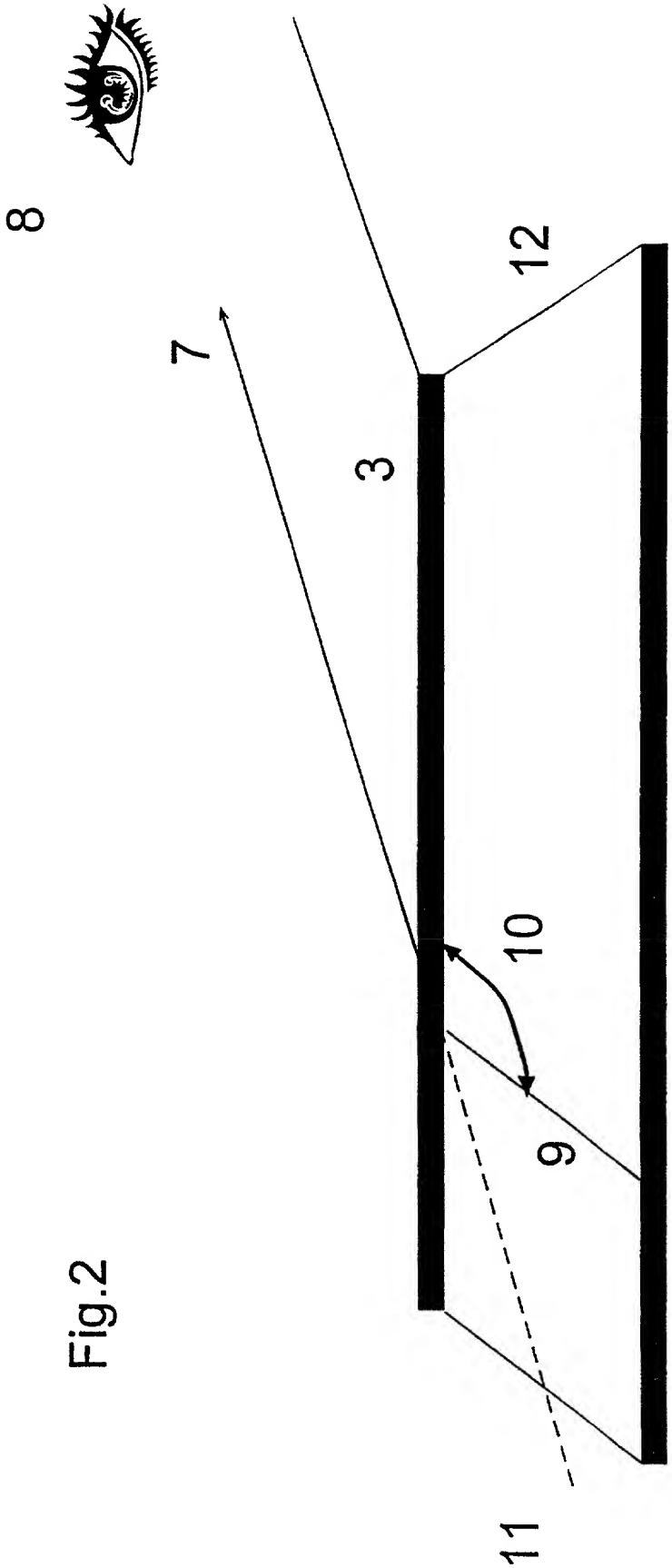

Fig.2

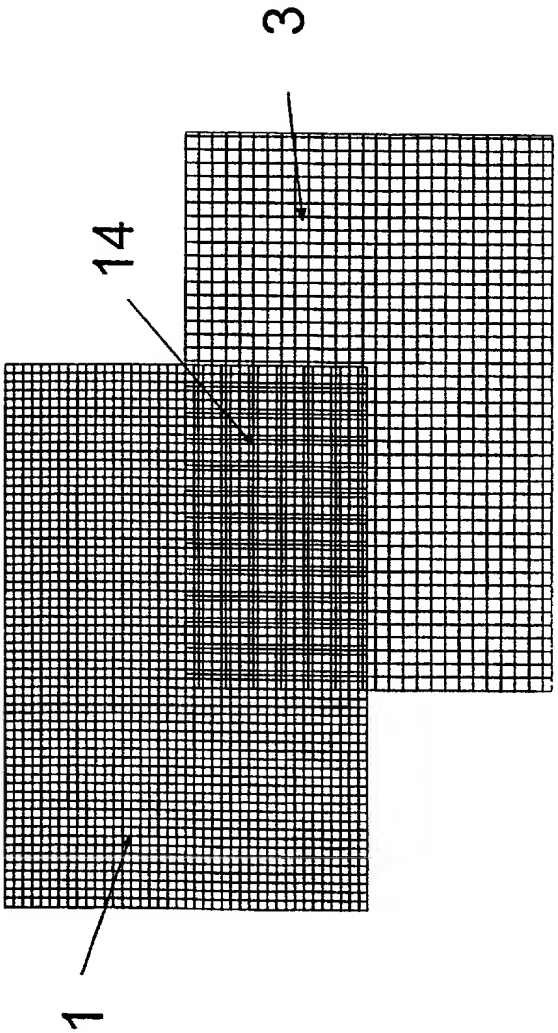

Fig.3

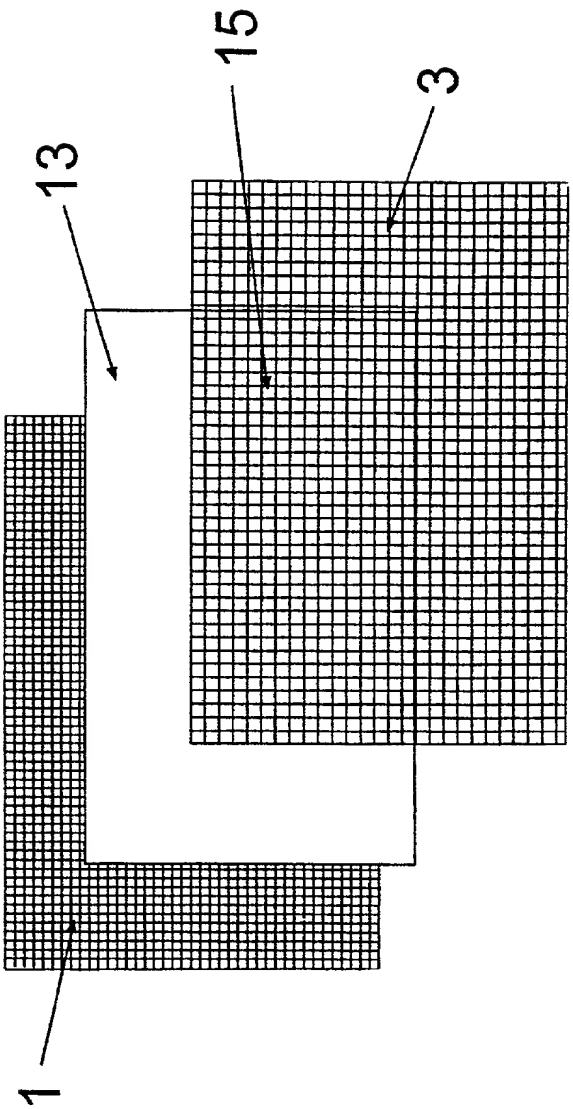

Fig.4

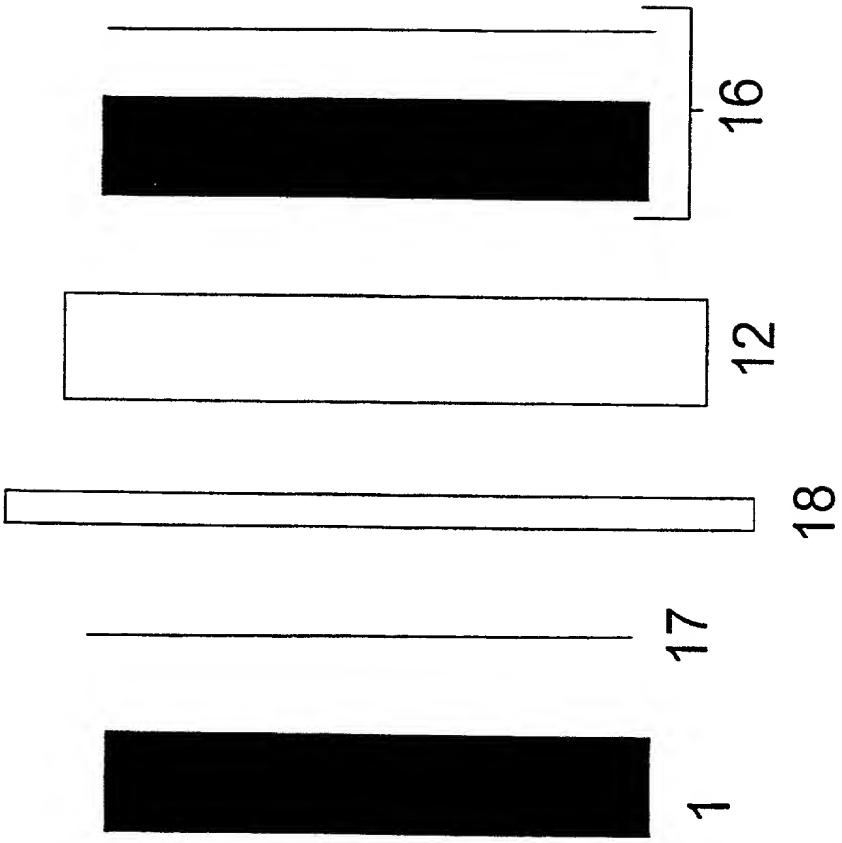

Fig.5

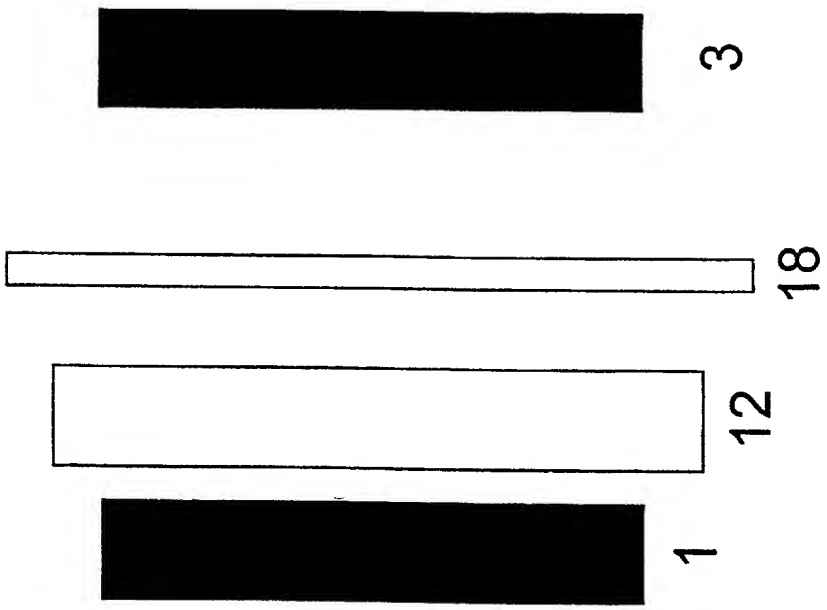

Fig.6

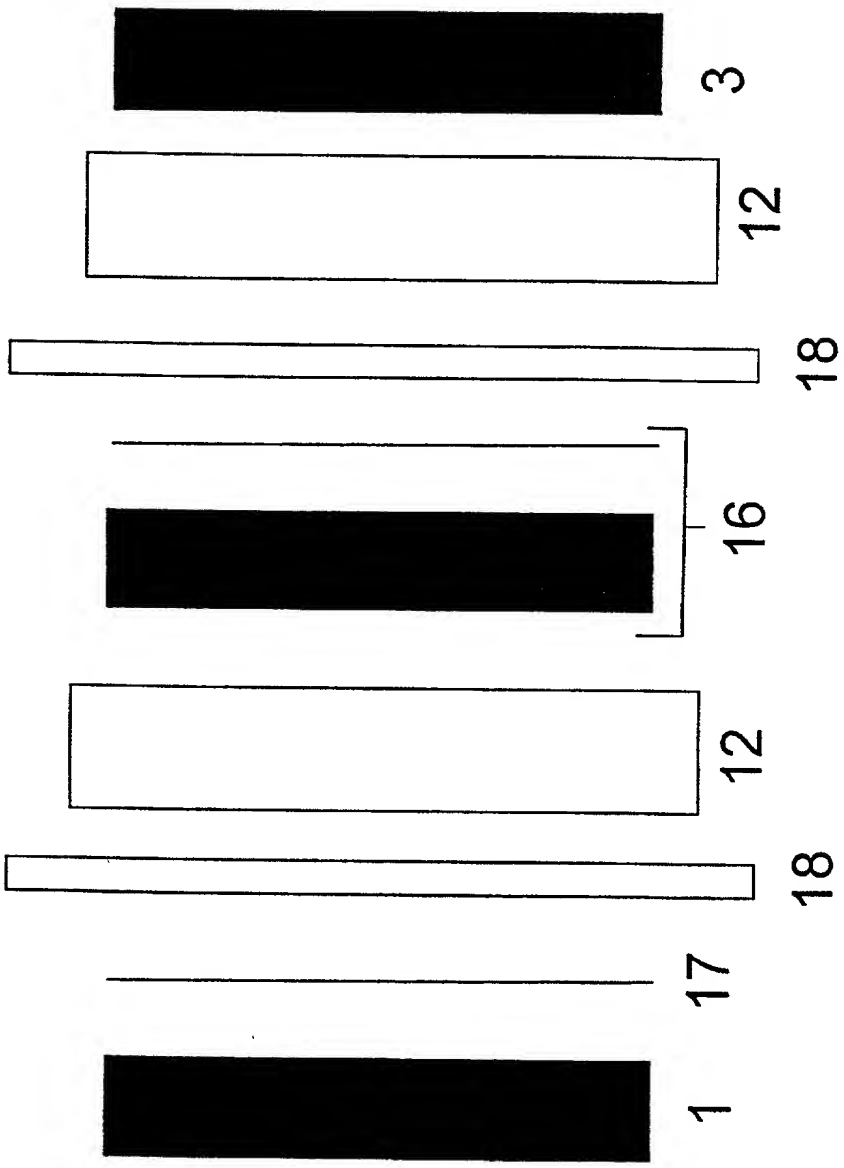

Fig.7

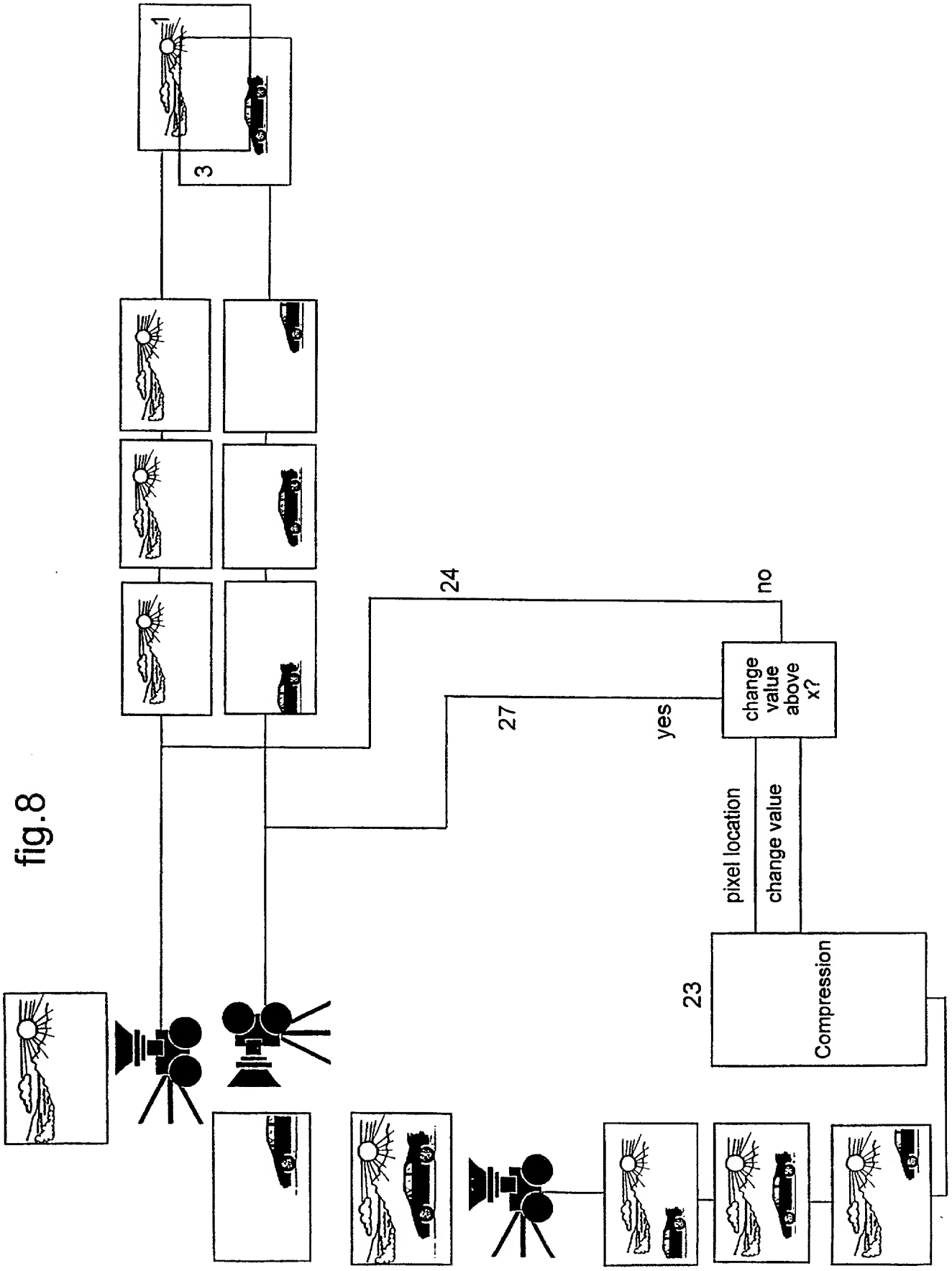
1
3
24
no
27
yes
change value above x?
pixel location
change value
23
Compression

fig.8

DECLARATION AND POWER OF ATTORNEY

As a below named inventor, I hereby declare that: My residence, post office address and citizenship are as stated below next to my name; I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled:

A MULTI-LAYER DISPLAY AND A METHOD FOR DISPLAYING IMAGES ON SUCH A DISPLAY

the specification of which:

is attached hereto; or

was filed as United States Application Serial No. 09/622,535
on August 18, 2000, and was amended on _____
(if applicable); or

was filed as PCT International Application Number PCT/NZ98/00098
on July 10, 1998 and was amended on June 16, 2000
(if applicable).

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above. I acknowledge the duty to disclose information which is material to patentability as defined in 37 CFR § 1.56.

I hereby claim foreign priority benefits under 35 U.S.C. § 119(a)-(d) or § 365(b) of any foreign application(s) for patent or inventor's certificate or § 365(a) of any PCT international application(s), designating at least one country other than the United States, listed below and have also identified below any foreign application(s) for patent or inventor's certificate, or any PCT international application(s) having a filing date before that of the application(s) of which priority is claimed:

Country	Application Number	Date of Filing	Priority Claimed Under 35 U.S.C. 119
New Zealand	329817	February 20, 1998	☒ YES ☐ NO
New Zealand	329834	February 24, 1998	☒ YES ☐ NO

I hereby claim the benefit under 35 U.S.C. § 119(e) of any United States provisional application(s) listed below:

Application Number	Date of Filing

I hereby claim the benefit under 35 U.S.C. § 120 of any United States application(s) or § 365(c) of any PCT international application(s) designating the United States, listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States or PCT international application(s) in the manner provided by the first paragraph of 35 U.S.C. § 112, I acknowledge the duty to disclose information which is material to patentability as defined in 37 CFR § 1.56 which became available between the filing date of the prior application(s) and the national or PCT international filing date of this application:

Application Number	Date of Filing	Status (Patented, Pending, Abandoned)

Attorney Docket No.:08059.0002

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